Soil Quality team

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Good Soil Condition is Key to No-till Tobacco

By Henry Sink, Sr., Davidson County Tobacco Farmer

I was raised on a small family farm in Davidson County, North Carolina where my family produced corn, cotton, sweet potatoes and tobacco. My father was concerned with erosion of the land. To control this erosion he used contour water furrows in the rolling fields on our farm. Then in the early 1930's my father adopted terraces as a better way of controlling erosion.

As I continued to be actively involved in agriculture in the mid to late 1960's, conservation tillage became a better way to control erosion of the land. At this time we planted our first acreage of corn with a modified planter. The chemicals that were available at this time did not control weeds and grasses. In some areas in the field, we were unable to harvest the corn. So we went back to conventional tillage until the late 1980's.

In the early 1990's with the purchase of proper equipment and the availability of other chemicals we went 100% No-Till except tobacco. In 1997 we included No-Till tobacco in test plots.

We have had good results on a continuing basis with no-till tobacco. As I see it, there are three requirements for success: (1) Get your mind made up that it will work, (2) Have a transplanter that does a good job, and (3) Have a soil that is of good condition for good plant root growth.

With good crop rotation and the use of long-term no-till, our land is in good condition for no-till tobacco. One field we used had previous erosion so bad we just seeded it down and left it for about 20 years.

Year 1997 – When the chemical Spartan became registered and was available, we decided to try a No-Till tobacco plot. With the help of our local and state NRCS, cooperative extension personnel and Dr. Morse of Virginia Tech, the technicians from Virginia Tech brought their two-row No-Till transplanter to our farm and set out one and one-quarter acres of tobacco. North Carolina State University technicians also brought their one-row- No-Till planter and set one-acre.

We had some problems: One was that the day the transplants were scheduled we had to set the tobacco out regardless of the soil conditions. Also, the recommended application rate of Spartan was not sufficient to take care of the broad-leaf weeds late in the season. The yield of the No-Till tobacco was comparable to the yield of the conventional-till tobacco, however.

Year 1998 – In 1998 we used the transplanter from North Carolina State University to set 1.6 acres. We had an excellent cover crop; good weed control because the rate of Spartan had been adjusted. On this plot we tried several rows where the wheat had been mowed for hay. This evidently allowed the ground to warm faster and the tobacco where we had mowed the cover off appeared to grow faster. Later, as the weather changed and got hot and dry, the benefits of the plants growing where there was a good cover crop was very evident. Although we irrigated the tobacco in other fields, this plot was not irrigated but the plants with the heavy crop residue did not suffer from the lack of moisture.

We had a problem with the transplants not being placed in the ground correctly. The plant becomes crooked and since it never form roots above the root ball, it has a tendency to roll or be blown over and not stay in line with the other plants. With conventional tillage you would move soil up to the plant with cultivation and this would support the plant, keeping it in a straight line. With No-Till we are not cultivating. We had to have equipment to get the plant in the ground so it would not crook.

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We had to design and build a transplanter which would place the transplant in the ground deep enough to prevent this from happening. Since we do not grow our own plants, we are working with our supplier to get healthy transplants with a stockier stem. We had good growth and good yields off this plot.

Year 1999 – For the year 1999 No-Till tobacco crop, my grandson, Henry Sink, III, a 3rd year student at NCSU, wanted to try something different. We have a two-row bedder that had parabolic sub-soil shanks. He removed the disk bedder, mounted a disk opener in front of the shank and disk coulters on each side of the shank to keep the shanks from breaking up a wide area of soil. Then he mounted a rolling cultivator tine and a drag chain to pulverize the loose soil.

Then we sprayed the chemicals: Spartan, Command and Gramoxone (Burn-Down). This did not work very well because it was a two-trip operation with the main problem being able to keep the transplanter directly over the opening created by the subsoil shank. If the transplanter got off the row the plant was not placed into the ground properly, causing problems with livability and the crooked plant problem.

Year 2000 – For the year 2000 No-Till tobacco crop, we followed a rotation of corn, wheat and soybeans, followed by a cover crop of wheat at the rate of three bushels per acre, with fall fertilizer and spring top-dressing. This gave a good thick cover. We got a good burn-down and chemical control. Henry Sink, III, a senior at NCSU, decided for his senior project to design and build a No-Till tobacco unit. It was built in our farm shop. With the new prototype No-Till transplanter we had a good experience. Everything did not work perfect, changes were made, and some parts added, but by the time we were finished our No-Till transplanter was doing an excellent job. We were dry for an extended period of time and irrigated all of our conventional-till tobacco and only part of the No-Till tobacco was irrigated. The land had not been moldboard plowed since 1982. We had good chemical control, good growth and good yield. The No-Till was better quality and out yielded the conventional crop.

Year 2001 – The year 2001 No-Till tobacco crop was the easiest and best we have grown. This time we followed corn with a cover crop of wheat, fertilized in the fall and top-dressed in the spring. The only difference was an early burn-down. Then we came back with a second burn-down to control rye grass and applied our other weed control chemicals at this time. We use Admire in the transplant water and applied all fertilizer at transplanting. The next trip over the field we sprayed for budworms and hornworms. Our next trip was the application of our contact and systemic sucker control. Then harvest of our best yielding and quality tobacco crop ever. Our yield was 4,500 pounds per acre.

Quality was excellent, every bale graded top. This crop did not have any graded primings. The tobacco at the bottom of the stalk was as clean as that at the top. The 2001 crop was not irrigated. It did not ever become weather stressed.

Year 2002 – What a difference a year can make. Our rotation is a thick cover crop of wheat following corn. The weather, mainly lack of rainfall did not give us a very thick cover crop. It was so dry when we started setting that the sub-soil shanks did not want to go in the ground, but after a one-half inch rain we were able to complete transplanting. This was the driest summer I have seen in my 85 years. The total rainfall from April through August was less than eight inches. We irrigated our tobacco with four inches of water. The quality of our crop continued to be excellent, but our yield dropped down to 3000 pounds per acre this year.

Things to think about when considering No-Till tobacco:

1. Acreage:
2. Field selection: A field selected should be; one that does not have a weed or grass problem in the last year or two; the soil surface is reasonable level (no ridges or deep ruts); and has been No-Tilled with a corn, wheat, soybean rotation. Soil seems to work better after soybeans.
3. Cover Crop: In the Fall, sow a cover crop of small grain at the rate of 3 or 4 bushels per acre and fertilizer. Rye is the preferable cover crop because it has a natural herbicide in the plant and gives you early growth. Fescue, crimson clover and hairy vetch are also good cover crops. The only problem we see with fescue sod is getting the soil firmly pressed around the transplant.
4. Burn-Down: Where fescue is the cover or where perennials are present in the cover crop, use Round-up four weeks before transplanting. Then just before planting come back with Gramoxone Extra, Spartan and Command. If you have a lot of disturbed soil or a grass problem, you can post emerge Devrinol over the plants. The only problem we have encountered was if the subsoil slit was not completely closed.
5. Transplanting: No-Till transplanting of tobacco is no different than that of any other No-Till crop. You start with a soil test, then select the best variety for your operation, then use the proper equipment to place the plant and fertilizer in the soil properly.
6. Harvesting: The tobacco will be slower to ripen with No-Till, which delays the harvesting a week or more. The bottom leaves do not burn off as fast, but the big difference is the amount of sand that is on them. There is very little. Another advantage is even after a heavy rain you can harvest without mud being on your tractor tires. Wet but not muddy.

Closing:
My concerns with the incentives to plant No-Till tobacco in the year of 2003 is that farmers without the proper equipment, which is not available, will try No-Till and will, after problems that we encountered at first, say "It won't work for me". You need to establish a good cover crop, apply the proper chemicals and obtain equipment that will properly transplant the crop and make the necessary changes to fit your operation.

No-Till tobacco can work for you by saving the soil and making you money, if you are willing to accept the challenge. And you can continue to improve the land at the same time.

Henry C. Sink, Sr.

Editor's Note: Mr. Sink is very active at age 85 and grows all his tobacco with no-till.

Continuous No-Till Improves Soil Structural Stability

ByCharles W. Raczkowski & Keith R. Baldwin, North Carolina A&T State University

Back in late spring of 2002 we were involved in a "Soil Quality Workshop" for North Carolina Cooperative Extension agents and Natural Resources Conservation Service field staff. At that workshop, we demonstrated the measurement of soil physical properties and discussed how they relate to soil quality. Based on our research interest, we decided to discuss the concept of soil erodibility and demonstrate the measurement of field parameters used as indices of this property. To accomplish this, we had to search for a soil with improved physical properties. Our search ended when we met Mr. Ray Styer, a Rockingham county cattle farmer who has been practicing no-till for many years. The results obtained in the workshop with Mr. Styer's soil were remarkable, thus the reason for this article.

Mr. Styer grows mostly silage corn and a rye-vetch-clover winter cover mix. An article written by Mr. Styer on the Soil Quality Team newsletter published back in June 2002 (vol.5, ed.2) describes his operation in detail and discusses his reasons for becoming a full-time, no-till practitioner.

Purpose of Demonstration

The objectives of our presentation were to discuss important erosion concepts and parameters, to conduct a hands-on field exercise to measure those parameters, and to relate the results of this exercise to soil quality. Erosion parameters measured included aggregate stability, splash detachment and sheet erosion.

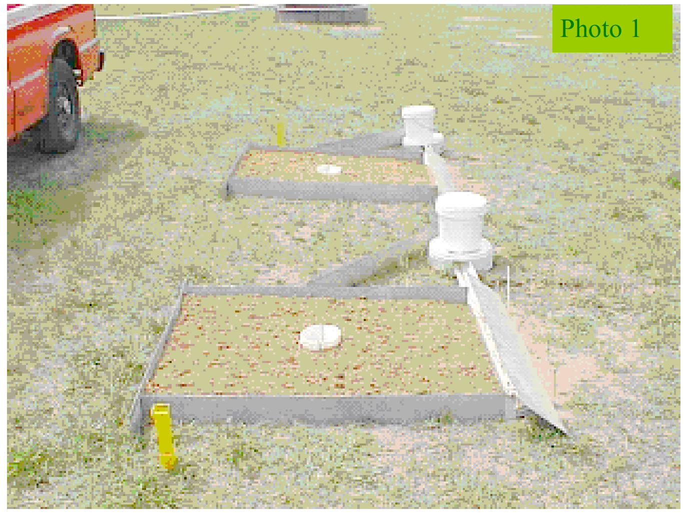
The Parameters

Aggregate stability refers to the resistance of soil aggregates to breakdown by water and is commonly used as an index of soil erodibility. The most common procedure for testing the water stability of soil aggregates is wet sieving. In general, a known amount of aggregates of specific size is used for this procedure. The aggregates are spread on a sieve, immersed in water, and oscillated for a specific time period. The percentage of aggregates remaining on the sieve is then determined.

For soil erosion to occur soil particles must be detached from the soil mass and transported to a new location. Detachment occurs when: 1) raindrops impact the soil surface and, 2) water flows over the soil surface. Detachment by raindrop impact is a process known as **splash detachment**. The erosion resulting from the combined processes of detachment by raindrop impact and transport by thin sheets of water flowing over the soil surface is called **sheet erosion**. This type of erosion can do severe damage to a field over the long term.

Soil Preparation

Soil was collected from the Styer Farm and from an adjacent farm having the same soil series (Cecil). The area sampled in the adjacent farm had been rototilled for many years. Each soil was sieved through a half-inch sieve, thoroughly mixed, and air-dried. About two gallons of each soil was passed through a number of sieves varying in size to determine the distribution of soil aggregates.



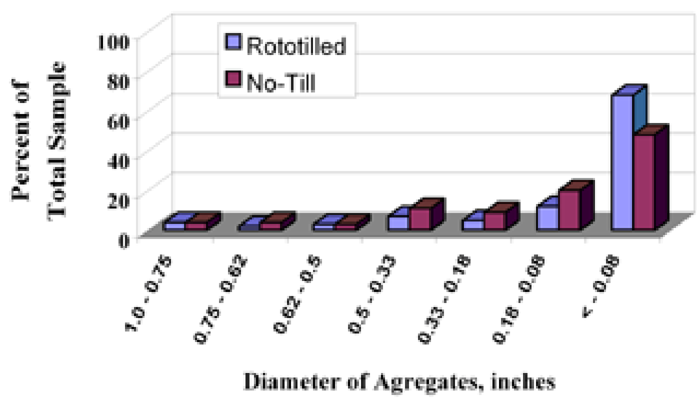
Erosion Plots

Two erosion plots were prepared, one for the no-till soil and one for the rototilled soil (Photo 1). Plots were 12 square feet (3 x 4 ft) and enclosed with sheet metal borders. A PVC trough was installed along the down-slope end to trap runoff during the rainfall simulation exercise. To measure splash detachment, a plastic container and funnel were buried in the center of each plot to trap airborne soil particles detached during the rain simulation (Photo 2). Rainfall was simulated with lawn sprinklers, which were calibrated to deliver 0.6 inches of rain during the 15-minute demonstration.

Results

The distribution of soil aggregates for each soil is illustrated in figure 1. The percentage of aggregates larger than 0.5 inches in diameter was the same in the no-till and rototilled soils. However, the size distribution of aggregates was very different below the 0.5-inch size class. The rototilled soil had a larger percentage of aggregates less than 0.08 inches in diameter. This clearly reflects the "pulverizing" action of rototillage, which favors the production of small-sized aggregates. **The shift toward larger aggregates in no-till reflects increased aggregate formation, likely due to the cementation of particles by organic matter and other biological factors.**

Not only was there a shift to larger aggregate sizes in the no-till



soil, but also the stability of those aggregates proved to be greater than the rototilled. **Ninety percent of the no-till aggregates remained stable after oscillation in water (photo 3), compared to only 5% of the rototilled aggregates.**

The rainfall simulation exercise successfully demonstrated the effects of a rainfall event on different tillage systems, both visually and by comparing data collected from the two plots. Runoff, infiltration, splash detachment, and soil loss results are illustrated in figure 2.

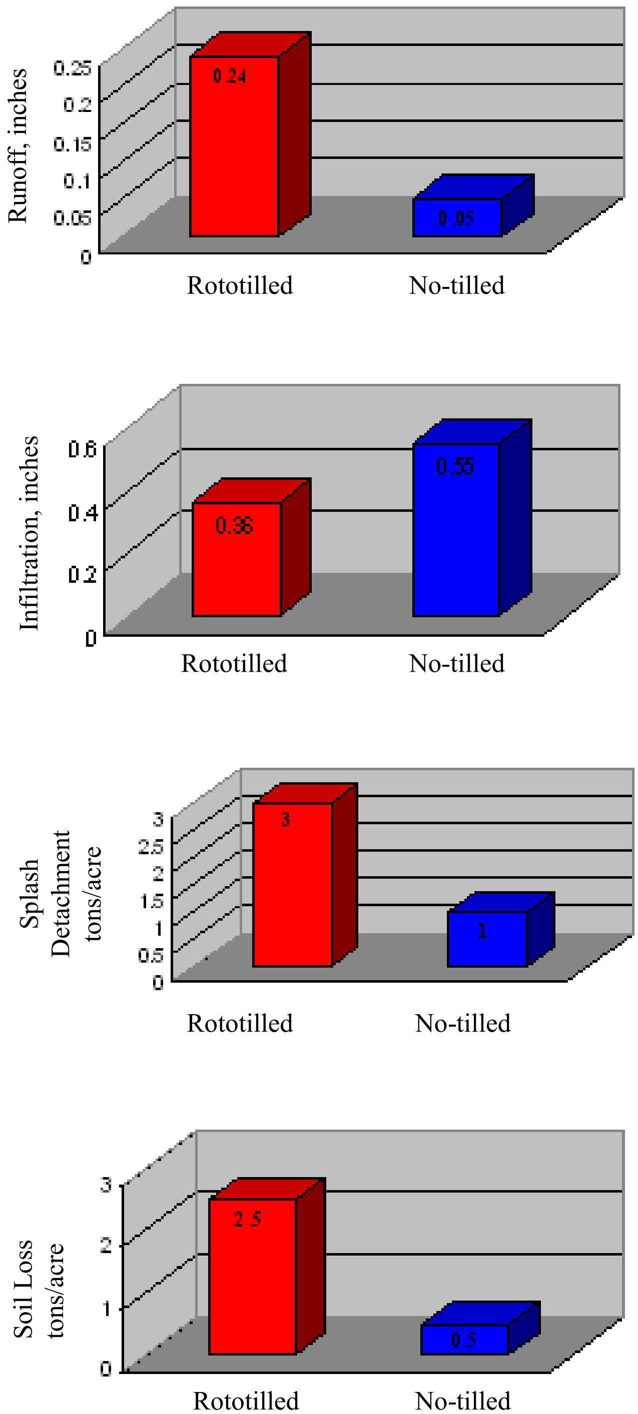


Fig. 2. Runoff, infiltration, splash detachment and soil loss obtained in rototilled and no-till soils.

We recorded the time it took for runoff to begin to collect at the lower end of each plot. **It took only 2 minutes for the soil surface to be completely sealed in the rototilled plot and for runoff to begin. In the no-till plot, runoff began after 7 minutes, and the soil surface was only partially sealed.**

The sediment content in the collected runoff was higher in rototilled than no-till, as evidenced by the cloudiness of the runoff water. This resulted from greater detachment of soil particles by raindrop impact in rototilled. Analysis of the data indicated that 2 tons/acre more soil splashed in rototilled than no-till. The increased soil splash is primarily the result of low aggregate stability.

There was less infiltration and more runoff in rototilled because the surface sealed quickly in the rototilled plot during the simulation exercise. The combined processes of detachment by raindrop impact and detachment and transport by surface runoff, increased the total soil lost by 2 tons/acre in rototilled as compared to no-till.

Implications

Since both the no-till and rototilled soils were from the same soil series, the **differences in soil management over the last 10 years** caused the changes in soil physical parameters that we observed in this exercise: increased aggregate stability and decreased erodibility. No-till soil management and the use of winter cover crops have improved the "quality" of Mr. Styer's Cecil soil, relative to his neighbor's Cecil soil.

Soil quality is commonly defined as the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries, to sustain plant and animal productivity, to maintain or enhance water and air quality, and to support human health and habitation. The interactions of soil chemical, physical, and microbiological properties define a particular soil's "quality" and determine how effectively the soil performs ecosystem functions. Agricultural ecosystem (agroecosystem) functions that are important to farmers include: 1) retaining and releasing nutrients and other chemical constituents, 2) partitioning rainfall at the soil surface into runoff and infiltration, 3) holding and releasing soil water to plants, streams, and groundwater, 4) resisting wind and water erosion, and 5) buffering against the concentration of potentially toxic materials.

At the Styer farm, we saw that improvements in soil physical properties resulted in **increased infiltration, reduced runoff, and improved soil quality**. Soil biological factors may have played a role in improving soil quality, too. Reduced tillage and the use of cover crops have been shown to increase soil humic matter and organic carbon content. These lead to increased microbial activity in soil. Soil microorganisms affect soil quality because they produce organic compounds (polysaccharides) that bind soil particles together in stable aggregates, improving soil tilth and structure.

Other important soil biological processes include: 1) decomposition of plant residue and organic material; 2) contribution to P and micronutrient availability, 3) biological N fixation; 4) biological control of plant diseases, nematodes, insects, and weeds; 5) biodegradation of synthetic pesticides or other contaminants; and 6) enhancement of drought tolerance of plants. The soil fungal biomass has been found to play a mayor role in aggregate formation and stabilization.

It is important to note that microbial activity in soil increases with regular additions of organic matter. **Regular additions of organic matter contribute nutrients to soils, as well, improving soil chemical properties.**

In general, soil productivity is increased when farmers have a soil management plan in place that seeks to improve soil physical, biological, and chemical characteristics. When these characteristics are improved, soil quality is higher. At the Styer Farm, no-till and cover crop management practices have accomplished this soil management goal.

Particulate Nitrogen

By Fern Paterson and Steve Coffey

As we refine our knowledge about nutrients, we learn that nutrient cycles are complex. Recent discoveries have shown that phosphorus moves in both the traditional particulate phase and also in the soluble phase. We also know that nitrogen has a both a particulate and a soluble phase. In order to be good stewards of soil quality, knowledge of the formation and movement of both particulate and soluble forms of nutrients is needed. This article continues with the theme of increasing the knowledge base on particulate nitrogen. Fern Paterson did a literature review for me a couple of years ago this is part of it.

Forms of Particulate Nitrogen

Particulate nitrogen is an insoluble, plant unavailable form of soil nitrogen that is formed when a nitrogen compound becomes fixed to a particle of clay or organic matter. The original nitrogen compound can be either organic or inorganic. The presence of either organic or inorganic forms of particulate-N in soil runoff can be quantified by determining the difference between filtered and unfiltered Total Kjeldahl Nitrogen (TKN) tests, which measure the organic-N and NH_4-N content of soil solutions.

Inorganic particulate nitrogen is formed when positive ammonium ions are adsorbed within the crystal structure of certain 2:1 clays. Typically, clay minerals capable of fixing potassium ions also are capable of fixing ammonium ions, including vermiculites, fine-grained micas (illites), and occasionally montmorillonites and smectites. Because clay content is often higher in the subsoil, ammonium particulates will be held in B horizons at a greater concentration than at the soil surface. In clays with a high 2:1 clay content, fixed ammonium ions can constitute up to 10% of the surface soil nitrogen, and considerably more in the subsoil (Brady and Weil 1999).

The concentrations of fixed and free ammonium ions in soil are in equilibrium. Any reduction in the total ammonium concentration in soils will result in a net desorption of ammonium fixed to clay particles. Similarly, long-term ammonium additions to soil, such as regular NH_4NO_3 fertilization, will result in a net increase in ammonium particulate concentration (Baethgen and Alley, 1987).

Organic particulate nitrogen is more diverse in form. Overall, organic-N, whether in residual, biomass, particulate, or soluble form, accounts for about 90% of total nitrogen in most surface soils (Kelley and Stephenson, 1996). Particulate organic nitrogen exists mostly as simple amino acids and amino sugars left from the partial decomposition of organic matter. While these compounds can exist in soluble form, often they will bind to particles including clay minerals (montmorillonite in particular) and humic matter (Weber, 1999). Organic particulate nitrogen can also be formed when inorganic nitrogen ions in fertilizers bind to soil humic matter. Studies show that up to 1/3 of fertilizer-N can remain fixed to soil organic matter one full growing season after the addition (Kelley and Stephenson, 1996). This suggests that heavily fertilized soils would have a higher concentration of organic particulate nitrogen than unfertilized soils.

Particulate Nitrogen in North Carolina Soils

North Carolina soils are predominately Ultisols (suborder Udult), the soil order that covers that majority of the southeastern United States. These are highly weathered, high acidity, low fertility soils. The mineralogy consists of high iron and aluminum oxide concentrations and 1:1 kaolinite clays (Brady and Weil, 1999). While kaolinite clays have a low nutrient holding capacity, they lack the sticky and plastic characteristics that reduce the workability of 2:1 clays. With adequate fertilization to increase nutrient content, Ultisols can be very agriculturally productive. Some soils Ultisols in North Carolina also contain montmorillonite, a 2:1 clay. Soils with this mineralogy are most commonly found in the Piedmont regions.

Montmorillonite clays and the heavy additions of ammonium-rich fertilizers almost guarantee the presence of some fixed ammonium in North Carolina Ultisols. However, other characteristics of inorganic particulate nitrogen suggest that it may be less common than in other regions of the country. As mentioned earlier, fixed ammonium is most closely associated with vermiculite clays, largely absent from North Carolina Ultisols. Vermiculites are more common in Alfisols, Mollisols, and Vertisols found in the northern United States and in Canada (Brady and Weil, 1999). It is also true that the ammonium fixation reaction is favored in alkaline soils with a pH at or above 7.0 (Weber, 1999). Ultisols, however, are much more acidic with the pH usually lingering around 5.5.

It is also important to note that the montmorillonite clays found in North Carolina soils are mostly contained in Bt horizons found 15 or more centimeters below the soil surface (Daniels, 1984). This depth protects the soil and the associated inorganic particulate nitrogen from forces of erosion. However, as is often the case in North Carolina, heavy tillage and/or erosion can expose these subsurface horizons, creating the possibility of inorganic particulate nitrogen reaching surface waters through runoff.

Organic particulate is also present in Ultisols. As stated previously, organic nitrogen can become absorbed either to clay or humic matter. The clay mineral most associated with organic nitrogen is montmorillonite, available in the North Carolina Piedmont. This suggests the existence of nitrogen containing organic compounds (i.e. amino acids) adsorbed onto inorganic montmorillonite clay particles.

Also, reactions involving the synthesis of inorganic nitrogen and humic matter are favored by highly acidic soils with a pH of 5.5 or below, just about the pH level of Ultisols (Weber, 1999). This suggests the presence of inorganic nitrogen compounds (i.e. NH_4NO_3 fertilizers) adsorbed onto organic colloids in humus. This later reaction is of particular interest when considering threats of surface erosion because both humic matter and nitrogen compounds added by fertilizers are in the top few centimeters of soil, and so will be the resulting particulate nitrogen. It is also important to note that the use of sludge or animal manures as a fertilizer will increase both the organic matter and nitrogen concentrations in the surface soils, thereby increasing possibility of organic particulate-N formation.

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Agroecology Research Project Examines Benefits of Conservation Tillage Systems

By Dr. Jeff Novak (USDA-ARS), Florence, SC

The Agroecology Program at Clemson University's Pee Dee Research and Education Center in Florence, SC has recently completed its fifth year of research and outreach. This collaborative program between the USDA-ARS and Clemson Univ. was initiated in 1997 with the goal of enhancing the profitability and environmental sustainability of Coastal Plain cropping systems and to determine the ecological impacts from the long-term use of these systems. One study, coordinated by Drs. Phil Bauer (USDA-ARS) and Jim Frederick (Clemson Univ.), is the Split Landscape experiment where a 14-acre field (Corn-Cotton rotation) has been split in half to compare an innovative cropping system to a traditional system. The innovative system uses practices such as conservation tillage, broadcast deep tillage, narrow row spacing (corn only), precision applied P and transgenic varieties, while the traditional cropped side includes practices such as disking/cultivating, in-row subsoiling, 30-38 inch row spacings, broadcast P fertilization and conventional varieties and pesticides. The Split-Landscape study has provided a wealth of information including site-specific yield and soil quality data, as well as information on environmental impacts (see http://www.agroecology.clemson.edu).

Two scientists involved with the Split Landscape experiment, Drs. Jeff Novak (USDA-ARS) and John Hayes (Clemson Univ.), are examining the long-term effects of innovative and traditional management practices on nutrient, sediment movement, and soil organic carbon levels. As part of their evaluation, six 1/8-acre runoff plots were established in the fields (3 per system) and analyzed for water volume loss and sediment, nutrient and pesticide concentrations. Preliminary analyses of 3 years of storm water runoff data have shown that the field under traditional management had more runoff water volume and nitrogen losses compared to innovative management. Dr. Novak indicated, "Less water runoff means more water was available to the crop under innovative management". This is an important finding for farmers growing crops under severe water stress.

Soil organic carbon levels have declined in Coastal Plain soils because of the use of traditional disking methods that mixes in plant residue. A decline in soil organic carbon reduces the soils ability to retain nutrients, water, and pesticides. Dr. Novak is examining the use of innovative management practices that utilizes conservation tillage where plant residue is not mixed into the soil. Soils from both fields in the Split Landscape experiment have been sampled annually at two depths (0 to 1 and 1 to 6 inches). "After 5 years, the top inch of soil under innovative management had a significant increase in organic carbon compared to soils under conventional tillage" (Table 1). Conservation tillage caused an accumulation of plant debris at the soil surface that did not oxidize as rapidly as when residue is mixed into soil. Dr. Novak said "Increasing the organic carbon content in these sandy soils is important to maintaining soil quality and the soils ability to retain nutrients and reduce movement of nutrients into surface water systems". Dr. Novak is also examining the long-term effects of new cropping systems on other factors that affect soil quality, such as soil fertility.

Table 1. Soil organic carbon (OC) changes after 5 years of innovative and traditional tillage management.

		1998	2002	Change
Management	Soil depth (in.)	Lbs. O.C./acre		
Innovative	0-1	2397	2850	+453
	1-6	10,709	8749	-1960
Traditional	0-1	3028	2659	-369
	1-6	11,866	10,612	-1254

Farmer Riggin'

By Tim Etheridge, NRCS, Pitt SWCD

Tim Stancill grew up working with his father on the farm in southeastern Pitt County. He developed a love for the land that he has never lost. Tim also learned the importance of working on equipment when running a tobacco harvester at the age of twelve. Running the harvester included maintenance and repair on an as needed basis. After high school, he tweaked his welding and fabrication skills at Pitt Community College. Tim has been riggin' farm equipment to meet their needs for years.

The Stancill farm operation includes tobacco, cotton, corn, soybeans and wheat. These crops are being grown in a wide range of soil types varying in textural, moisture and drainage characteristics. Tim began experimenting with no-till soybeans before moving on to no-till cotton and wheat. Tim tried no-till using existing equipment (John Deere Max-Emerge) with mixed results. His planters were equipped with the shallow planting system for covering the seed and firming the seedbed. He encountered problems with poor soil to seed contact. When planting properly in stiff soil the seed were too deep in sandy soils. Early planting in wet natured soils also presented a soil temperature problem.

Tim was not satisfied with the results of the previous year and began to modify his planter. He added a new tool bar up front and mounted two coulters per row, seven inches apart. Also added to the front of the planter was a set of row cleaners. The two coulters serve to loosen the soil without destroying the residue. The row cleaners also helped with sweeping away residue and leveling the seedbed area. Both of the changes assisted with an improved seedbed and better depth control of the planter.

Tim was pleased with the improvements, but still had some problems to work on. The row cleaners worked well in most of the field, but caused another problem in areas of high residue. The residue being moved was being placed under the planter gauge wheels causing another depth control problem. He was not satisfied with the way the shallow planting system was covering and firming the seedbed. Another set of row cleaners was rigged behind the first set to sweep the residue beyond the gauge wheels. Also gone was the shallow planting system. It was replaced with regular press or closing wheels. Tim also added a way to apply a herbicide ahead of the coulters, using the coulters for minimal incorporation.

The planter did well, but at times the press wheels did function as well as Tim expected. In tighter soils, he encountered some problems with seedling emergence due to crusting. In lighter soils, the press wheels almost pinched the seed out of the ground. He has now replaced one of the solid press wheels with a spiked or spaded wheel including a gauge wheel to control the depth. This improvement has decreased the side wall compaction and has improved his stands.

Tim enjoys planting no-till crops. He believes that he, the environment and the soil benefit from no-till planting. Tim emphasized how each year seems to present different challenges due to changes in soil moisture, amounts of residue and compaction during harvest. He feels that he can now adjust his planter to work as he expects in most conditions encountered. If another problem surfaces, he is ready to "rig" up a solution.